Prehospital Pediatric Care

Shock
And
Shock Management

Provider Manual

Prehospital Pediatric Care Provider Manual

Acknowledgement

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This module will require approximately two hours to view the videotape, complete the workbook and discuss the concepts. The workbook has some added information on pathology of shock and congenital heart defects which are not discussed in the videotape.

Your local protocols regarding MAST, CPR, Intraosseous Infusion and other specific treatments for shock should be reinforced during the discussion time.

As with earlier modules, Shock can be utilized individually or in group sessions, but please remind the learners to follow the directions and work back and forth between the videotape and workbook.

The last section deals with the skill of pediatric vascular access and may not be appropriate for EMT -Basics. It is appropriate for use during an actual "hands on" practice session for EMT -I and Paramedics. The practical session for vascular access is planned for about three hours depending on the number of students.

The instructional modules are designed to reinforce learning, promote interaction and facilitate problem solving.

Table of Contents

Introduction

An understanding of the dynamic physiology of shock, awareness of causes, recognition of signs and symptoms unique to children and competence in the application of knowledge are the goals of this program on pediatric shock and shock management.

Pediatric Shock
Pathophysiology – Part A

Shock is defined as the inadequate perfusion of tissues and organs by oxygenated blood and the inadequate removal of metabolic wastes from the body resulting in cellular destruction and organ failure. This definition is the same for adults and children.

In order to have a healthy/functioning body, adequate levels of oxygen must be available for use during the process of metabolism. In addition, the waste products of metabolism must be removed. Normal metabolic wastes are acid in nature and are very toxic to the vital organs of the body. A breakdown in either the supply of oxygen or the removal of wastes results in shock.

Children are very susceptible to shock, especially hypovolemic shock. Their body weight is comprised of proportionally large amounts of water and water is necessary for chemical reactions throughout the body.

Children have proportionally small volumes of blood and blood carries oxygen molecules to the tissues and organs. Blood volume can be estimated by multiplying the child's weight in kilograms by 80cc.

Determine kilograms by either dividing pounds or using the 1-5-10 rule.

Weight in lbs + 2.2 = kilograms
Or
1 year old = 10 kilograms
5 year old = 20 kilograms
10 year old = 30 kilograms

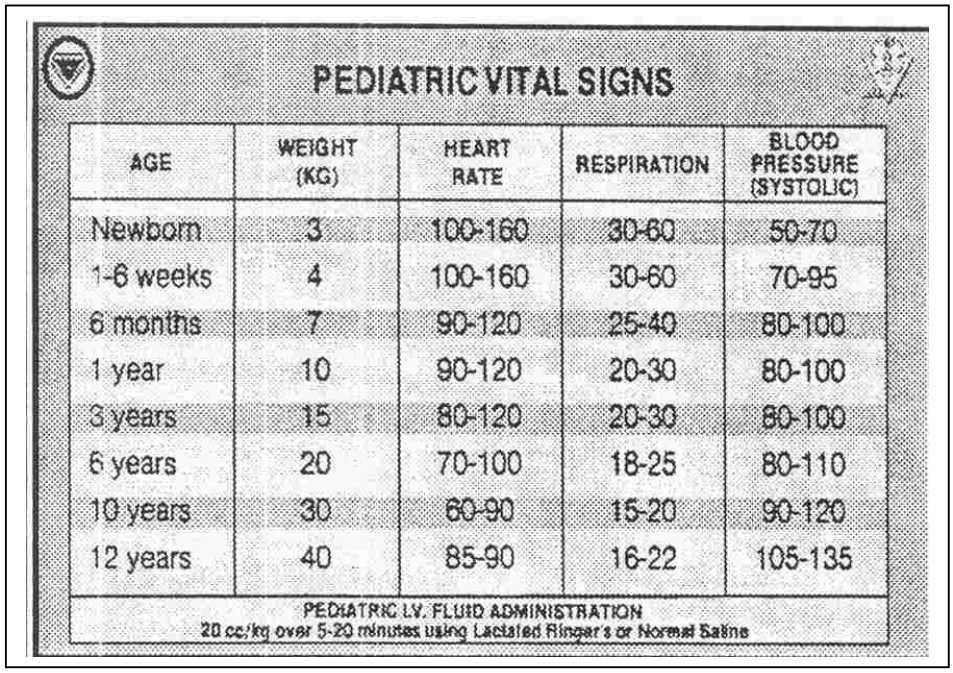
After determining weight in kilograms, multiply using the formula of 80cc per kilogram. (The average adult is estimated to have 5,000-6,000 cc blood volume.)

By using this rule, you could estimate that a 3 year old will weigh 15 kilograms.
15 X 80 = 1 ,200 cc of blood or vascular volume.

Unrecognized or untreated shock results in hypoxemia and acidosis which in turn causes multiple system failure, including cardiovascular collapse.

CARDIOVASCULAR COLLAPSE

Tachycardia is the common pediatric arrhythmia with hypovolemia and shock, but it is also a physiologic response to fear, pain and fever. Tachycardia is defined as any rate faster than the normal range for the age of the child.



PEDIATRIC VITAL SIGNS

AGE	WEIGHT (KG)	HEART RATE	RESPIRATION	BLOOD PRESSURE (SYSTOLIC)
Newborn	3	100-160	30-60	50-70
1-6 weeks	4	100-160	30-60	70-95
6 months	7	90-120	25-40	80-100
1 year	10	90-120	20-30	80-100
3 years	15	80-120	20-30	80-100
6 years	20	70-100	18-25	80-110
10 years	30	60-90	15-20	90-120
12 years	40	85-90	16-22	105-135

PEDIATRIC I.V. FLUID ADMINISTRATION
20 cc/kg over 5-20 minutes using Lactated Ringer's or Normal Saline

Bradycardia is the most common LETHAL pediatric arrhythmia associated with late shock. When hypovolemia is compounded by hypoxemia and acidosis, the tachycardia will change to BRADYCARDIA and then ASYSTOLE or CARDIAC ARREST. Bradycardia in children must be treated by appropriate oxygenation and ventilation to prevent cardiovascular collapse. Bradycardia is defined accordingly:

Newborn: Pulse less than 100
Infant: Pulse less than 80
Child: Pulse less than 60

VIEW VIDEOTAPE PATHOPHYSIOLOGY OF SHOCK PART A

DESIRED OUTCOMES

Once you have completed the Introduction and Part At you should be able to:

1. Define shock.

   _____

2. Describe two Physiological factors that predispose children to hypovolemic shock.
   a. _____
   b. _____

3. Calculate the amount of blood volume in a child who weighs 18 lbs.

   _____

4. Calculate the amount of blood volume in a 5-year-old child using the 1-5-10 rule.

   _____

5. Describe the effects of excessive metabolic wastes on the pediatric heart.

   _____
   _____

6. List the three fluid compartments or fluid spaces in the body.
   a. _____
   b. _____
   c. _____

7. Name the compartment which contains the majority of fluid?

   _____

8. Describe the most common pediatric problems which cause fluid to be lost from the above fluid space?

   _____

QUIZ

The quiz questions are meant to help you evaluate your comprehension. There is only one correct answer for each question. Your instructor has the answer key.

1. Which of the following best defines shock?
    a. Inadequate tissue perfusion
    b. Lack of oxygen causing low blood pressure and rapid heart rate
    c. Organ failure due to acidosis
    d. Loss of blood or body fluid resulting in decreased blood pressure

2. Which of the following factors predisposes children to hypovolemic shock?
    a. An immature immune system
    b. The physiologic response of the pediatric heart to hypoxemia
    c. An immature central nervous system
    d. The large proportion of water to total body weight

3. A child who weighs 10 lbs would be estimated to have how much blood volume?
    a. 86 cc's
    b. 150 cc's
    c. 360 cc's
    d. 1000 cc's

4. Using the 1-5-10 rule, a 7 year old child would weigh how many kilograms?
    a. 14 kilograms
    b. 25 kilograms
    c. 50 kilograms
    d. 3.5 kilograms

5. The cardiac arrhythmia most often seen in children with fever, pain and early hypovolemia is?
    a. Tachycardia
    b. Bradycardia
    c. PVC's
    d. Children have healthy hearts and do not respond with any arrhythmia

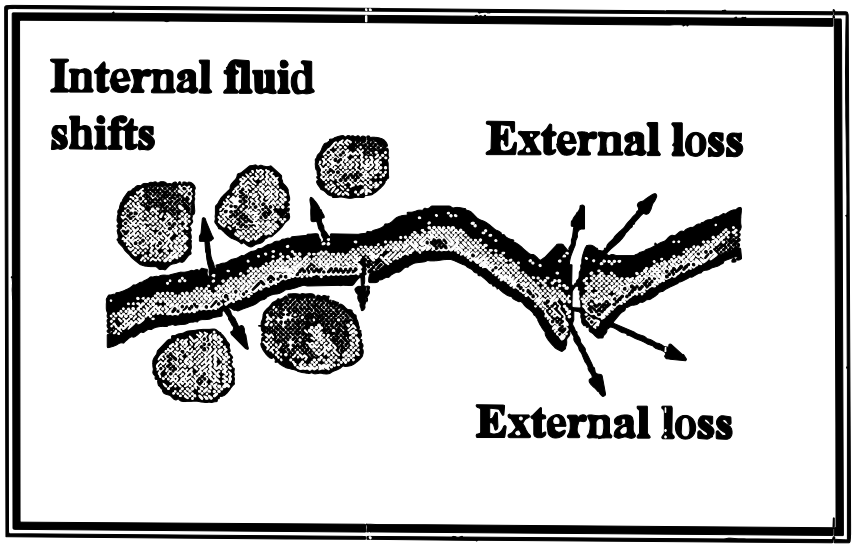
6. The largest amount of water is located in which fluid compartment?
    a. Intracellular
    b. Interstitial
    c. Vascular
    d. Distributive

7. Fever, tachypnea, vomiting and diarrhea result in fluid being lost from which compartment?
    a. Intracellular
    b. Interstitial
    c. Vascular
    d. Distributive

8. Which of the following is considered the most significant pre-arrest condition in a pediatric patient?
    a. Decreased level of consciousness
    b. Tachycardia
    c. Bradycardia
    d. Hypotension

Pediatric Shock
Etiology – Part B

SHOCK: HYPOVOLEMIC



Any form of bleeding or hemorrhage can lead to hypovolemic shock. In children the most common cause is blunt trauma, most often resulting from motor vehicle accidents.

When intravascular volume is depleted and oxygen carrying red blood cells are lost, the body tissues and organs become hypoxic.

Definition: Hypoxia – decreased oxygen level in tissue and cells

Definition: Hypoxemia – decreased oxygen level in arterial blood

Hypoxic cells cannot perform normal metabolism and convert to anaerobic (without oxygen) metabolism. Anaerobic metabolism is less efficient, produces wastes which are difficult for the body to excrete and lead to the condition of acidosis.

Definition: Acidosis – an abnormal accumulation of acids which distort body pH.

ACIDOSIS is not consistent with life.

The definitive treatment for hypovolemic shock due to hemorrhage is replacement of the lost blood. Prehospital interventions only stop continued bleeding, supply oxygen and provide vascular volume but do not correct the depletion of red blood cells. Thus, rapid transport is paramount!

Disorders which deplete fluids from within the cells (intracellular) also cause hypovolemic shock. This occurs because the body shifts fluid out of the vascular space and into the cellular space in an attempt to correct the problem. However, the result is a depletion of vascular volume, a decrease in cardiac output and once again, cellular and tissue hypoxia.

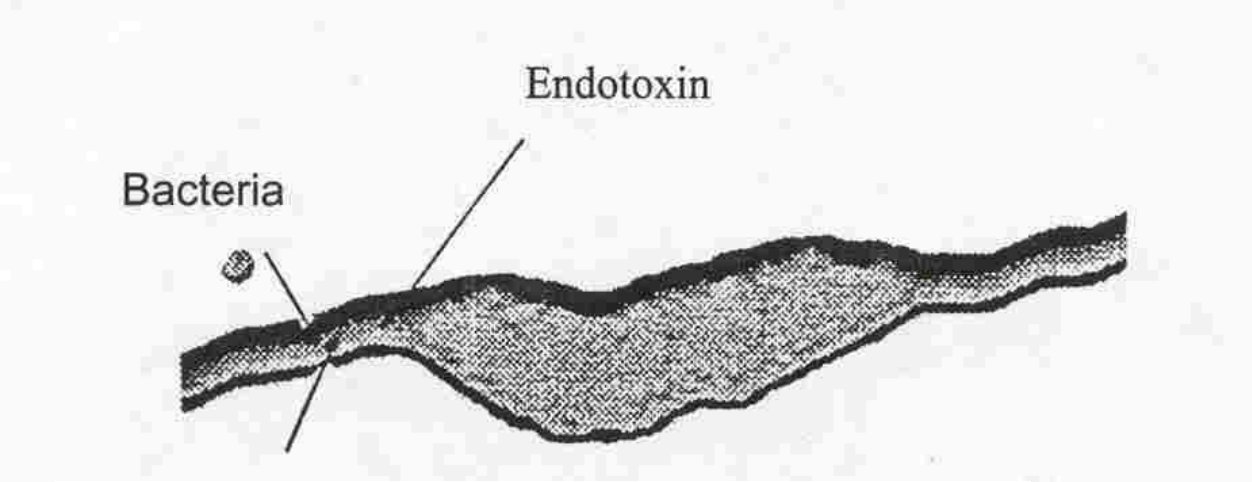
In children, disorders which deplete intracellular fluid are: severe diarrhea, prolonged vomiting, fever causing excessive perspiration and severe burns.

Signs of dehydration accompany this form of shock and can alert prehospital providers to impending problems.

	DEHYDRATION	
SIGNS & SYMPTOMS	**MILD**	**SEVERE**
Skin color	Pale	Gray/Mottled
Skin turgor	Decreased	Poor
Mucous membranes	Dry	Parched
Urine Output	Decreased	Absent
Blood pressure	Normal	Decreased
Pulse	Normal/Incr.	Rapid
Cap refill time	<2 seconds	>3 seconds

Treatment of hypovolemic shock due to intracellular fluid loss involves the replacement of lost fluid and correction of acid/base imbalances.

SHOCK: SEPTIC



Vessel Dilation = Blood Pooling = Decreased Cardiac Output

Endotoxins released from certain bacteria invade the bloodstream and cause cardiac depression and decreased vascular resistance leading to dilation of the arterial vessels, It is as though blood or fluid has been lost because the movement of oxygenated blood has stagnated. Cells become hypoxic and acidosis results. In addition, organs are invaded by the bacteria, and normal organ function is altered.

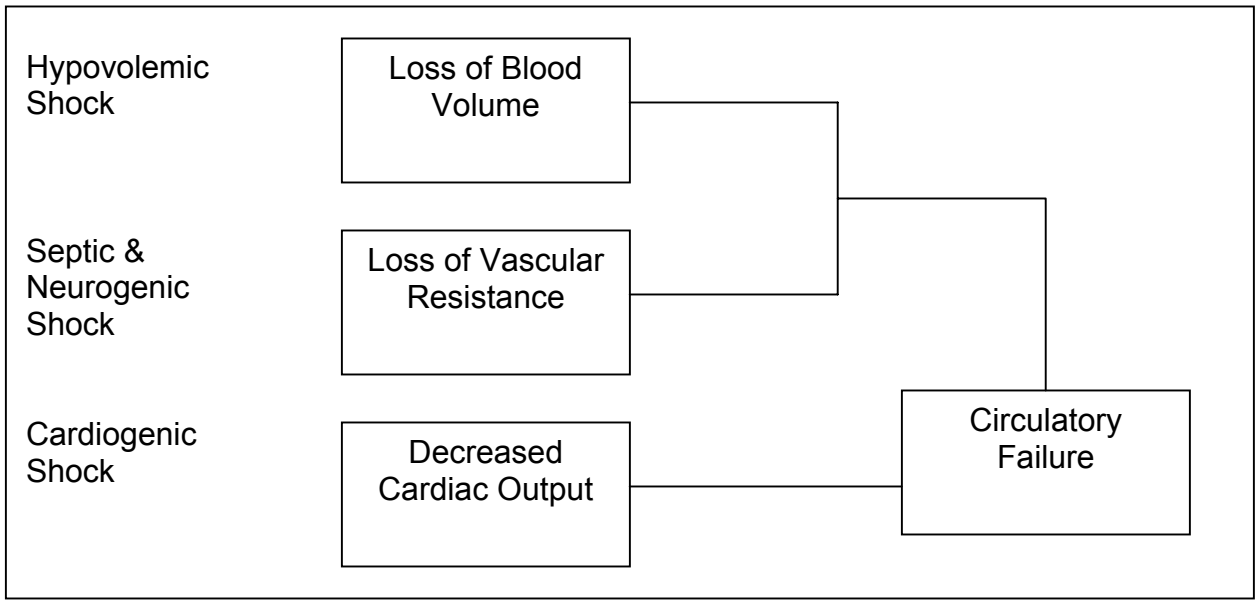
Infections are common in neonates and children due to their immature immune systems and developmental characteristics which expose them to increased sources of infection.

Symptoms of infection usually precede the catastrophic effects of sepsis. Chills, fever, tachycardia, tachypnea and confusion usually are followed by profound hypotension and cardiovascular collapse.

Overall treatment is complex and focused on antibiotics and reversal of organ failure. Prehospital support of the ABC's and rapid transport are vital to outcome.

Administration of fluid plays a vital role here too for providers able to obtain vascular access and initiate proper fluid bolusing.

SHOCK: NEUROGENIC



When the spinal cord is severed or damaged, normal sympathetic stimulation, which controls the ability of arterial vessels to expand and contract (vascular resistance) is lost. The arteries throughout the body vasodilate and the normal amount of blood is inadequate to fill the cardiovascular system.

Blood pools, does not return to the heart in sufficient quantity, and so cardiac output is decreased. As in all the other types of shock previously described, decreased cardiac output causes inadequate amounts of oxygen to be available to the cells. They convert to anaerobic metabolism and acidosis results.

Symptoms of neurogenic shock are usually mild tachycardia and hypotension and require less aggressive intervention unless the injury is high in the spinal cord and affects the diaphragm, causing respiratory depression.

However, be suspicious of a patient with a spinal cord injury that is in severe shock; there could be an undetected source of hypovolemic shock.

Note: Both septic and neurogenic shock are sometimes categorized as distributive since they physiologically create alterations in the distribution of fluids.

SHOCK: CARDIOGENIC

Inability of the heart to pump

1. **Coronary**
   - **Not usually seen in pediatrics**

2. **Non-Coronary**
   - **Acidosis**
   - **Congenital defects**
   - **Trauma**
   - **Drug ingestion/hypothermia**

Cardiogenic shock in children occurs due to depression of normal cardiac function by drug ingestion, hypothermia, acidosis, trauma and congenital heart defects. Cardiogenic shock is not frequently seen in children but the physiologic consequences are similar to those already described.
REVIEW: Impaired pumping action of the heart leads to decreased cardiac output, systemic circulatory failure, inadequate perfusion, cellular hypoxia and acidosis. Cardiogenic shock is increasingly seen as a result of the ingestion of tricyclic antidepressant drugs which alter normal electrical/mechanical responses of cardiac cells. Elavil (Amitriptyline) and tofranil (Imipramine) are typical examples of tricyclics seen in pediatric ingestion.

Trauma and violence which cause impaired cardiac function by tamponade or contusion result in cardiogenic shock. Once rarely seen in children, such conditions must now be suspected if the mechanism of injury involves penetrating or blunt injury to the chest.

Congenital heart defects are unique to the pediatric patient and although not commonly seen, they cause both primary pump failure and chronic congestive heart failure. An understanding of these conditions is important to quality pediatric care.

Common abbreviations:

CHD = congenital heart defect
CHF = congestive heart failure
VSD = ventricular septal defect

CONGENITAL HEART DEFECTS

There are 35 well-recognized congenital heart defects in children, but the most common is ventricular septal defect (VSD) which is defined as a defect in the wall between the right and left ventricles.

The exact cause of congenital heart defects (CHD) is not known, but the following factors are associated:

1. Maternal rubella
2. Maternal alcoholism
3. Maternal age over 40 yrs.
4. Maternal insulin dependent diabetes
5. Some genetic influence

Congenital heart defects (CHD) most often manifest themselves during the first six months of life. They alter the normal hemodynamic function of the heart and result in congestive heart failure and hypoxemia.

EMS will most often respond to previously diagnosed children who are in chronic CHF. The parents should be able to help provide a history and baseline data such as: respiratory status/chronic retractions/crackles; continual cyanosis; and cardiac medications/surgery.
Even though most congenital heart defects are diagnosed by the time an infant has reached 6 months of age, you may encounter an infant or young child whose condition has not been recognized.

Any infant with signs of inadequate perfusion, poor color, poor feeding or respiratory distress should be suspected of CHD until proven otherwise.

The diagnosed child with CHD will experience complications, especially CHF due to such problems as: respiratory infections, varying response to medications or abnormal heart function.

The signs and symptoms of congestive heart failure include:

A. Pulmonary Congestion or Respiratory Distress;
    1. Tachypnea, grunting, nasal flaring
    2. Crackles or wheezing with auscultation
    3. Orthopnea (difficulty breathing when lying down)
    4. Cyanosis may or may not be present depending on the specific defect
    5. Respiratory distress during feeding

B. Impaired Cardiac Function;
    1. Tachycardia during sleep; extreme with exertion
    2. Fatigue with sucking or eating; irritable
    3. Poor perfusion, cold extremities, weak pulses, low B/P, delayed capillary refill, mottled skin

C. Systemic Venous Congestion (difficult to see in infants);
    1. Peripheral edema
    2. Weight gain
    3. Distended neck and peripheral veins

Prehospital treatment of problems related to congenital heart defects is symptom specific. Treatment with oxygenation and ventilation is standard but all other treatments must be guided by medical control.

In cases of newly diagnosed problems or severe complications, the child may be transported to a children's or tertiary care center for definitive care. However, many problems including initial stabilization, will be handled by a pediatrician or family physician and the area hospital. Always consult with local resources and facilities for guidance.

VIEW VIDEOTAPE ETIOLOGY OF PEDIATRIC SHOCK PART B

DESIRED OUTCOMES

Once you have studied the workbook and viewed Part B of the videotape, you should be able to:

1. List the most common cause of shock in children.
   _____

2. Describe two examples of the most common cause of pediatric shock.
   a. _____
   b. _____

3. Describe the alterations in body physiology which result from all forms of shock.
   _____
   _____
   _____

4. Outline the manner in which septic shock alters the cardiovascular system and creates a shock syndrome.
   _____
   _____

5. Name the type of shock which is similar to septic shock in the way it alters the arterial vasculature.
   _____

6. List four factors, other than CHD, that cause cardiogenic shock in children.
   a. _____
   b. _____
   c. _____
   d. _____

7. Name the most common congenital heart defect.
   _____

8. List at least three symptoms of CHF for each of the following:
   a. Pulmonary congestion:
      1. _____
      2. _____
      3. _____
   b. Impaired cardiac function:
      1. _____
      2. _____
      3. _____
   c. Systemic congestion:
      1. _____
      2. _____
      3. _____

9. Describe a prehospital error or mistake made when dealing with head injured children who have signs of shock.

   _____

   _____

10. Describe the unique anatomy which can allow a head injured infant to develop shock which is due to intracranial bleeding.

    _____

11. Describe the intervention for treatment of Hypoglycemic shock other than fluid replacement and glucose.

    _____

QUIZ

Complete the following quiz for each question. There is only one correct answer for each question.

1. Which of the following types of shock is the most common form seen in children?
    a. Cardiogenic
    b. Septic
    c. Hypovolemic
    d. Hypoglycemic

2. Hypovolemic shock, resulting from intracellular fluid loss, commonly occurs due to?
    a. Hemorrhage
    b. Spinal cord damage
    c. Endotoxins from certain bacteria
    d. Vomiting and diarrhea; burns

3. The pathophysiological condition which is the result of all forms of shock and leads to death is?
    a. Hypoxia
    b. Acidosis
    c. Hypotension
    d. Oliguria

4. Hypoxemia is best defined as?
    a. Decreased or deficient breathing
    b. Inadequate supply of oxygen in the cells
    c. Deficiency of oxygen in the arterial blood
    d. Oxygen deficient metabolism

5. All of the following statements regarding acidosis are true except?
    a. Acidosis is best treated by the administration of whole blood
    b. Acidosis is not consistent with life
    c. Acidosis occurs as a result of anaerobic metabolism
    d. Oxygenation and ventilation may help correct acidosis

6. Signs and symptoms of septic shock occur due to?
    a. Decreased vascular resistance and cardiac depression due to endotoxins
    b. Decreased functioning of the kidneys and brain due to cellular inflammation
    c. Sympathetic responses stimulated by the invading bacteria
    d. An increase in intracellular fluid levels leading to hypertension and pulmonary edema

7. All of the following cause cardiogenic shock in children except?
    a. Trauma
    b. Drug ingestion
    c. Hypothermia
    d. Myocardial infarction

8. Neurogenic shock signs and symptoms occur due to?
    a. Decreased vascular resistance
    b. Increased cardiac output
    c. Loss of Intracellular fluid
    d. Decreased cardiac output

9. Which of the following statements is TRUE regarding shock in head injured children?
    a. Shocky, head injured children may be assumed to have neurogenic shock if they have no extremity fractures
    b. Shock in the head injured child can be due to intracranial bleeding if the patient is less than 12 to 14 months of age
    c. Isolated head injuries commonly exhibit signs of shock
    d. Shock in the head injured child is often caused by intracranial bleeding

10. Which of the following statements is NOT correct regarding the etiology of CHD?
    a. It can be caused by maternal alcoholism
    b. The exact cause is not known
    c. It can be caused by maternal smoking
    d. It can be caused by maternal rubella

11. Which of the following is NOT a correct description of the signs and symptoms of congestive heart failure ?
    a. Orthopnea and wheezing
    b. Chronic bradycardia and hypertension
    c. Tachycardia during sleep; fatigue
    d. Peripheral edema

Pediatric Shock
Assessment and History – Part C

Blood loss, fluid loss, decreased vascular tone and pump failure all lead down the same lethal path and many of the signs and symptoms of shock which you will see in your patients will be the same, regardless of the etiology involved.

Your overall goal in assessment is to recognize the presence of shock so you can prevent deterioration. It is helpful to understand if the signs and symptoms which you see are early or late signs. It makes a difference; a difference in the aggressiveness of your prehospital treatment and urgency of transport.

Assessment must always be accompanied by REASSESSMENT.

Please remember that children have the ability to compensate for failing cardiac output and poor perfusion; the signs of impending trouble may be very subtle.

Children rapidly deteriorate once past the period of compensation and resuscitation is difficult and often unsuccessful. Continual reassessment of signs and symptoms is imperative; do not allow yourself to be caught off guard and not recognize your patient's decompensation and deterioration.

EARLY SIGNS AND SYMPTOMS OF SHOCK

TACHYPNEA
Recognition of an abnormally fast rate requires that you be familiar with normal values or have access to a chart such as the one on page 7.

Tachypnea is a compensatory action by the body to remove metabolic wastes; the child is blowing off carbon dioxide.

Tachypnea utilizes energy and cannot be sustained. Younger children become exhausted and just stop breathing. You must intervene with oxygenation and at times, assisted ventilation.

TACHYCARDIA
This may be the only finding in early shock and to recognize an abnormally fast rate, you must be familiar with normal values for each age range or have access to a chart, such as the one on page 7.

Tachycardia may also be due to pain, fear, or fever. The history and setting will help make this distinction.

Tachycardia becomes lethal for all ages at 220. It may lead to fibrillation but more often progresses or converts to bradycardia. Bradycardia is a unique response in the pediatric patient and is a significant and late sign of deterioration.

DELAYED CAPILLARY REFILL
The body vasoconstricts the peripheral areas and skin as a defense mechanism and blood is shunted to the internal organs. Therefore, checking for capillary refill should be done at a central location such as over the sternum or forehead.

The shunting results in pale, cool, mottled skin and delayed capillary refill.

Normal capillary refill is less than or equal to 2 seconds. When vasoconstriction has occurred, capillary refill will increase to three or more seconds or not occur at all.

LATE SIGNS AND SYMPTOMS OF SHOCK

DECREASED PULSES
Weak or absent peripheral pulses indicate a severe failure of the pumping power of the heart and/or extreme volume loss.

NEUROLOGICAL IMPAIRMENT
The brain is quickly affected by decreased cardiac output and acidosis: you will observe a decreased level of consciousness. Children will often become irritable and agitated prior to becoming lethargic. You may see a pattern of agitation followed by lethargy, then confusion and unconsciousness.

CARDIAC ARRHYTHMIAS
Bradycardia is a PRE-ARREST ARRHYTHMIA and occurs in late shock. Bradycardia occurs as a response to severe acidosis and diminished cardiac output.

HYPOTENSION
It cannot be stressed enough that blood pressure tends to be "normal" until late in the course of shock. A child may lose up to 20-25% of their vascular volume before the blood pressure falls. The presence of hypotension is a grim sign of shock.

CARDIAC ARREST
The pediatric heart most often responds to the physiologic abnormalities of shock by resorting to bradycardia and then asystole. Bradycardia may be the only arrhythmia seen prior to complete arrest.

Early recognition and aggressive airway support are vital in the prevention of cardiac arrest in the pediatric shock patient. Once arrest has occurred, resuscitation is difficult and response to medications is poor.

PATIENT HISTORY

The patient history is important and you can attempt to determine the etiology of the shock, but PLEASE remember that a lengthy history must never delay necessary transport. By now you know those crucial facts that must be quickly obtained and what can be learned during transport.

In addition to the usual questions, there are certain history questions specifically relevant to shock.

1. Has the child had a fever? If yes, how long? Septic shock often has fever as a symptom.

2. Has the child had vomiting or diarrhea? If yes, how long? How severe? Remember--dehydration leads to hypovolemic shock.

3. Fever and dehydration will cause a decrease in urinary output. Ask about the number of wet diapers during the last 6-8 hrs.

4. Does the child have any congenital cardiac history? Also, look for surgical scars on the chest.

5. Is the child diabetic? Hypoglycemia may be due to diabetes, but more commonly, it is caused by physiological stress.

6. Has there been ANY unusual event occur to the child during the last 24 hrs. You are looking for trauma that at the time appeared harmless or exposure to a harmful substance or any other such forgotten occurrence.

VIEW VIDEOTAPE PREHOSPITAL ASSESSMENT AND HISORY -PART C

DESIRED OUTCOMES

After completion of this section of the workbook and videotape you should be able to:

1. Describe the overall goal of your assessment of a child with shock.

   _____

   _____

2. List three early signs/symptoms of shock.
   a. _____
   b. _____
   c. _____

3. Describe five late signs/symptoms of shock.
   a. _____
   b. _____
   c. _____
   d. _____
   e. _____

4. In addition to the usual pediatric history format, list six questions which may help to clarify the etiology of the shock.
   a. _____
   b. _____
   c. _____
   d. _____
   e. _____
   f. _____

QUIZ

Circle the correct letter. There is only one correct answer for each question

1. The primary goal in the assessment of a shocky patient is?
    a. To determine the etiology of the shock
    b. To decide if the late stages of shock are present
    c. To recognize the presence of shock and prevent deterioration
    d. To recognize the need for oxygen and IV fluid therapy

2. Which of the following is NOT true regarding the compensation mechanism of children?
    a. Children have poor ability to compensate
    b. Children rapidly deteriorate once past compensation
    c. Children have a great ability to compensate
    d. Children are difficult to resuscitate once compensation is lost

3. Which of the following is NOT true regarding the early signs and symptoms of shock?
    a. Tachypnea is a compensatory mechanism and a positive sign
    b. Tachypnea utilizes energy and will result in respiratory failure
    c. Tachycardia may be the only early sign of shock
    d. Tachycardia of 220 or higher is considered lethal in all children

4. When tachycardia changes to bradycardia, you should consider this?
    a. A sign of improvement
    b. A sign that the child's compensatory mechanism is handling the insult
    c. Proof that oxygen therapy is helping the problem
    d. A sign of impending danger

5. Which of the following is NOT an indicator of late shock?
    a. Capillary refill > 5 seconds
    b. Lethargy
    c. Tachycardia
    d. Hypotension

6. Which of the following would NOT be an appropriate history question in the assessment of a shocky child?
    a. Has the child had a nap today?
    b. Has the child had a fever?
    c. How many wet diapers has the baby had in the last 6-8 hrs?
    d. Has anything unusual happened to the child in the past 24 hrs?

Pediatric Shock
Prehospital Treatment – Part D

SCENE SURVEY:
A scene survey should always be performed. It not only protects you and your peers, but can reveal a mechanism of injury or insult and can help determine the etiology of the shock.

Next, complete the primary survey. Problems identified during the primary survey should receive immediate attention, even if subtle. If late symptoms of shock are found during the primary survey, initiate transport. If symptoms of shock are present but the etiology is unclear, treat for hypovolemia.

PRIMARY SURVEY:
AIRWAY:
MAINTAIN A PATENT AIRWAY; assess crying, talking or movement of air through the nose and mouth. Protect the cervical spine. Prevent obstruction from the tongue and DON'T hyperextend the neck. This obstructs the airway in small children and infants.

BREATHING:
ENSURE ADEQUATE RATE AND CHEST MOVEMENT; symptoms such as tachypnea, see-saw movements, retractions, pallor or cyanosis should be treated with 100% oxygen.

Bag/valve/mask assisted ventilation should not be withheld if the child's respirations are shallow, not effective for adequate ventilation or if apnea is present. Assisted ventilation in such situations should include 100% oxygen.

If ALS is available and late symptoms are evident, endotracheal intubation should be considered and requested. Take care: Improper placement is a grave complication! Remember the short distance to the carina! Accidental extubation is also extremely easy. Secure your tube and REASSESS breath sounds frequently.

Gastric distention leading to aspiration is a complication of both bag/valve/mask and endotracheal intubation assisted ventilation in the pediatric patient. Personnel who are properly trained should always insert a nasogastric tube when assisting ventilation except when treating a suspected head injury.

CIRCULATION:
CONTROL HEMORRHAGE; at this time the MAST garment is controversial and medical control should guide application. If applied, the abdominal section is not inflated in children under the age of 10 years. It restricts the diaphragm and leads to respiratory compromise.

EVALUATE HEART RATE; abnormal heart rates in children are BEST treated by the administration of 100% oxygen and assisted ventilation. If, after proper management of respiration, the infant's heart rate remains below 80 beats per minute, (or the child's heart rate remains below 60 beats per minute), chest compressions may need to be initiated. Even though local protocol may have pre-established standards for initiation of CPR in children, it is prudent to confer with medical control for guidance. Tachycardia can indicate an early sign of shock. A heart rate greater than 220 beats per minute indicates supraventricular tachycardia and can produce signs of shock in a relatively short time. Tachycardia should be treated by the administration of oxygen. If the child's condition is not stable, assisted ventilation with 100% oxygen and IV fluid replacement are needed for treatment.

ASSESS CAPILLARY REFILL AND BLOOD PRESSURE; delayed capillary refill and hypotension indicate the need for fluid resuscitation. Lactated ringers is the fluid of choice but some protocols utilize normal saline.

FLUID RESUSCITATION; the final section of this module provides details concerning fluid resuscitation of the pediatric patient. Make certain this procedure does not significantly increase your scene time.

GLUCOSE LEVEL; those personnel with advanced training and equipment should determine a blood glucose level. A device such as a glucometer is recommended for field use. Normal is 80-100%. If the level is below 40-60%, IV glucose should be requested from medical control. The formula of 2cc/kilogram of D25/W will determine the amount to be infused.

SECONDARY SURVEY:
A secondary survey will be done during transport since scene time remains a critical issue. Stabilize as is appropriate, transport as quickly as possible and reassess constantly.

VIEW VIDEOTAPE PREHOSPITAL TREATMENT OF SHOCK - PART D

DESIRED OUTCOMES

After you have completed Part D of the workbook and videotape, you should be able to:

1. Describe an action, normally used to open the upper airway, but which is contraindicated in the pediatric patient.

   _____

2. List (a.) the complication associated with both bag/valve/mask and endotracheal intubation assisted ventilation and explain the (b.) recommended treatment.
   a. _____
   b. _____

3. Discuss the guidelines for initiating CPR in pediatric patients.

   _____

   _____

4. Name the two IV fluids recommended for use in a child with shock.
   a. _____
   b. _____

5. List the level of blood sugar which indicates treatment.

   _____

6. Describe the formula and fluid which are used to treat hypoglycemia.

   _____

QUIZ

Circle the correct letter. There is only one correct answer for each question.

1. When late signs of shock are evident in a patient you should?
    a. Immediately request an IV
    b. Initiate transport
    c. Begin bag/valve/mask assisted ventilation with 100% oxygen
    d. Not be overly concerned since children compensate well

2. If signs of shock are present but the cause is unknown, you should?
    a. Treat for hypovolemia
    b. Do nothing; you may cause harm
    c. Treat for cardiogenic shock
    d. Repeat the patient history to see if you missed something

3. Which of the following methods of opening the airway is NOT recommended for pediatric patients?
    a. Oropharyngeal airway
    b. Jaw/thrust
    c. Hyperextension of head
    d. Towel under the neck

4. Pediatric patients who exhibit signs of shock should?
    a. Receive IV fluids of normal saline
    b. Be transported by helicopter
    c. Receive 100% oxygen
    d. Be placed in MAST trousers with legs inflated

5. A common complication of both bag/valve/mask and endotracheal intubation is?
    a. Acid/base imbalance
    b. Insufficient inflation of both lungs
    c. Gastric distention
    d. Hyperventilation

6. Which heart rate is considered the rate at which CPR should be considered/initiated in pediatric patients, 2-5 years of age?
    a. 100 beats per minute
    b. 70 beats per minute
    c. 60 beats per minute
    d. 50 beats per minute

7. You have a shocky 4yr old child (18 kg) who has bilateral fractured femurs, a blood pressure of 56/40 and pulse of 176. How much fluid should your first bolus of LR contain?
    a. 360 cc's
    b. 500 cc's
    c. 1200 cc's
    d. No fluid bolus is indicated; vital signs are normal for 4 yr old

8. The level of blood sugar at which glucose administration should be considered for children over 1 year of age is ?
    a. 100 to 120%
    b. 80%
    c. 40-60%
    d. 10-20%

9. Your patient is an 8 month old child who was dropped and is shocky. The hospital has ordered you to give a fluid bolus after starting the IV. The baby sitter states the infant weighs approximately 22 pounds. How many cc's of LR will you give?
    a. 50 cc's
    b. 100 cc's
    c. 150 cc's
    d. 200 cc's

10. Your patient is a 6 yr old who has been hit by a car while riding his bicycle. Which of the following vital signs is your primary indicator of his state of shock?
    a. That he is unconscious
    b. That his respiratory rate is 40
    c. That his pulse is 70
    d. That his blood pressure is 82/50

Pediatric Shock
Vascular Access and
Fluid Administration – Part E

Children who are demonstrating symptoms of shock and are at risk of deterioration prior to reaching definitive care are candidates for fluid administration. Whereas IV therapy is a rather easy intervention in the adult patient, it is a difficult intervention in the prehospital pediatric patient and requires careful consideration. IV therapy intervention should be a decision between you and your medical control.

Once the need for an IV is established, you should proceed in the following manner.

ORGANIZE AND PREPARE YOUR EQUIPMENT AND FLUID

Necessary equipment:

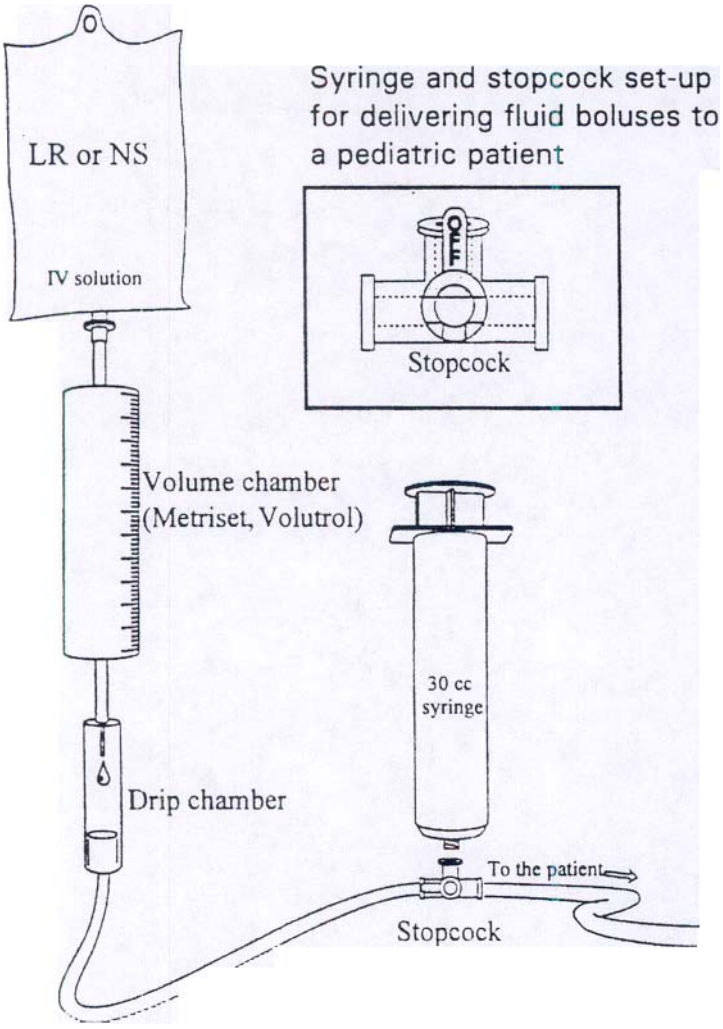
gloves	tourniquet
arm board	needles
tape	tubing
volume chamber	60cc syringe
T -connector and stopcock	skin prep (alcohol/betadine)

500cc bag of normal saline or lactated ringers solution

Have available some 2x2's and band-aids “just in case" you make more than one attempt.

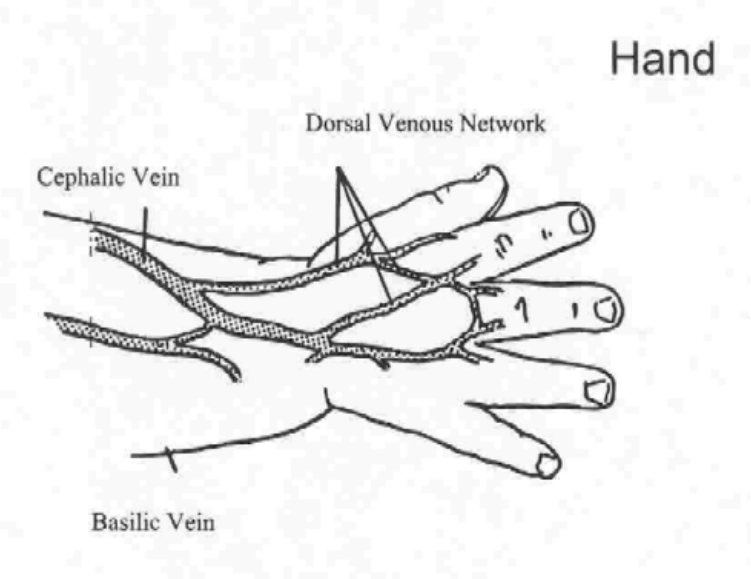
Connect the fluid bag to the volume chamber, then add the IV tubing. Fit the 60cc syringe to the stopcock. Connect the IV tubing into the appropriate side of the stopcock and the T -connector to the other. It is the T -connector which fits into the end of the catheter once it is inserted. Fill all tubing with fluid.

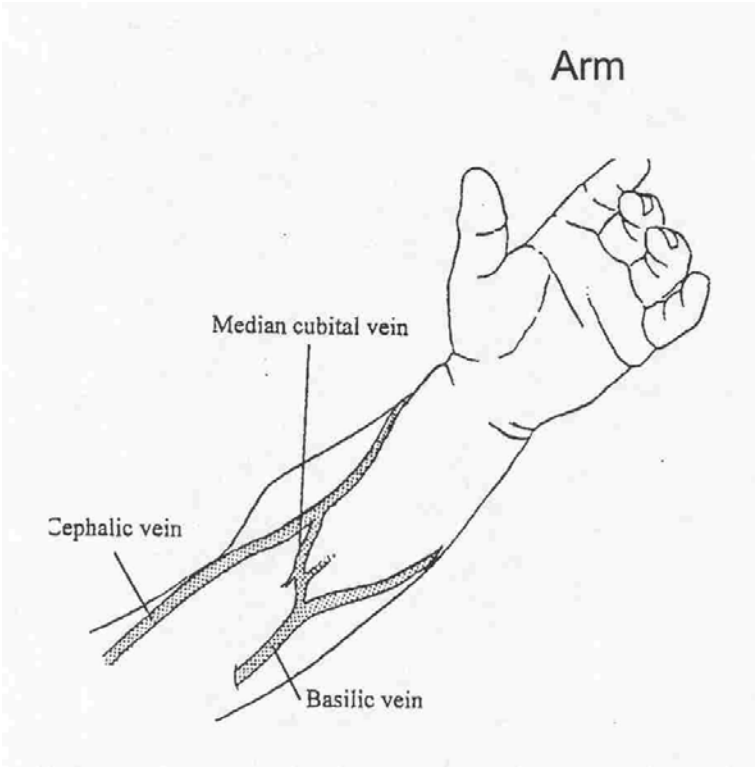
If you are unfamiliar with the equipment, it might be helpful to stop reading, look over the equipment (or at the diagram on the following page) and practice connecting the pieces of tubing.


Syringe and stopcock set-up for delivering fluid boluses to a pediatric patient
LR or NS
IV solution
OFF
Stopcock
Volume chamber
(Metriset, Volutrol)
30 cc syringe
Drip chamber
To the patient
Stopcock

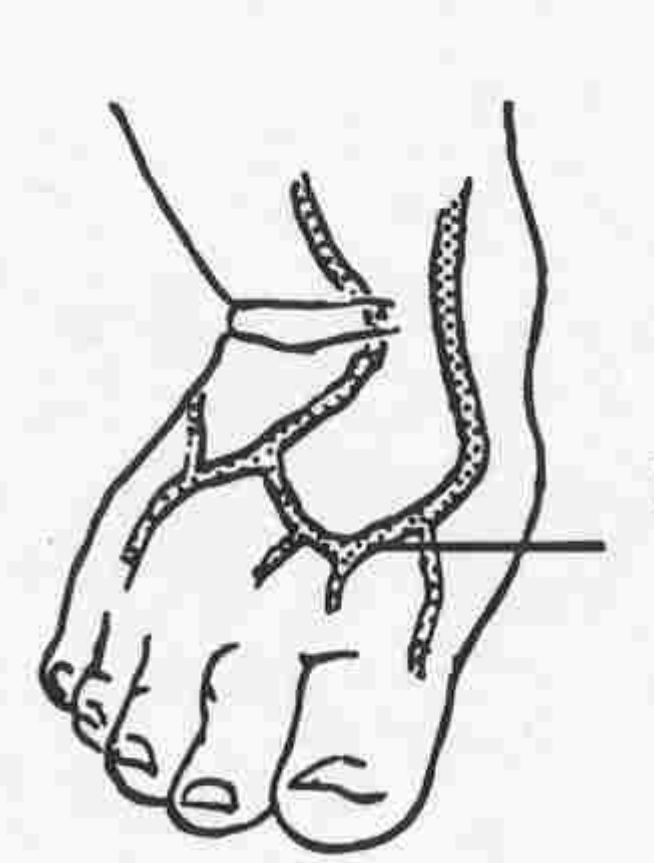
SELECT A SITE

The extremities of children provide appropriate sites for cannulation. Observe the diagrams.



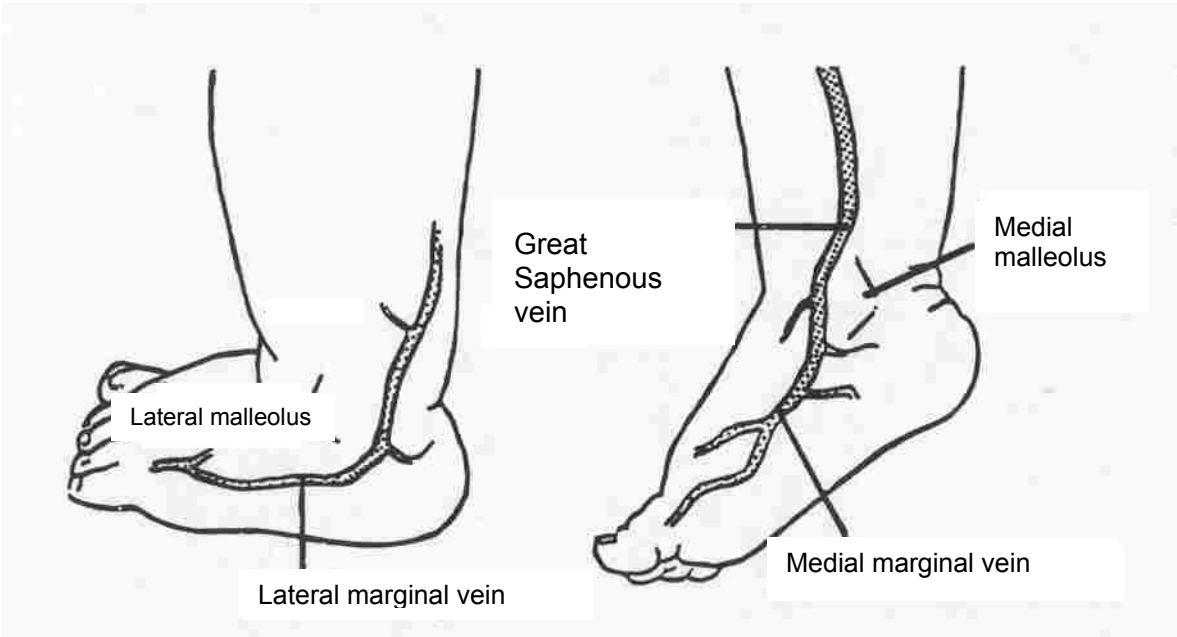


FOOT



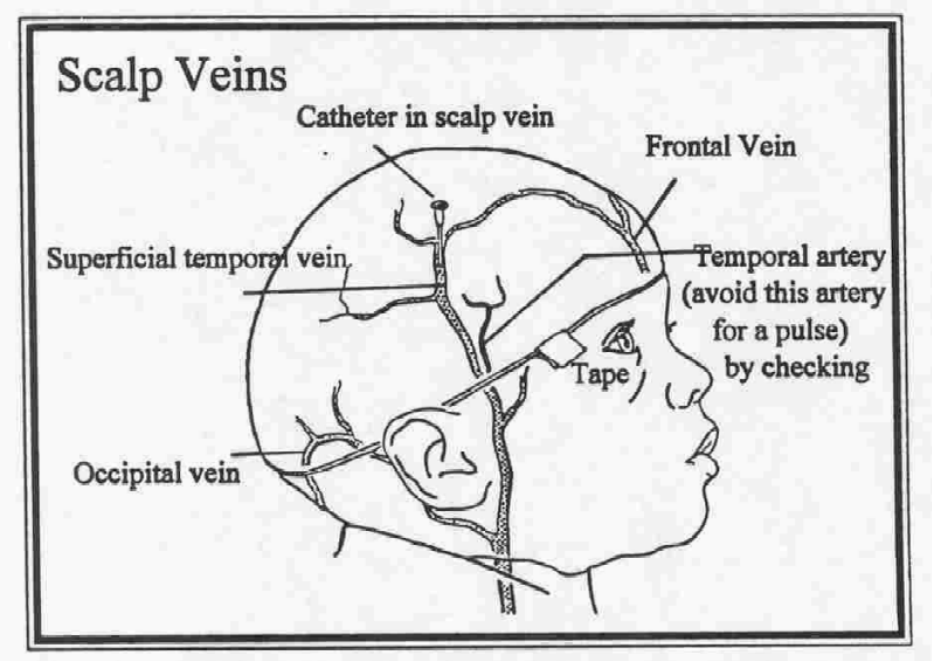
DORSAL ARCH

LOWER LEGS



Scalp veins can be used in infants in addition to the extremity sites. Observe the diagram. Your needle must be directed in the direction of the blood flow. Venous blood flow generally will go from the top of the head returning down to the heart. Position yourself at the top of the head and point the catheter towards the heart.

An elastic band placed as illustrated in the diagram below, may be used as a tourniquet to assist in visualizing the veins. You can also occlude the vein you have chosen with your finger and look on one side for slight bulging and on the other side for slight sunken appearance. The side with decreased volume or the sunken appearance is the direction of blood flow.



SECURE THE CHILD AND THE AREA
Nothing causes more distress to you and to your patient than to be successful in obtaining a patent IV only to have the child struggle and dislodge the needle. Take time to secure the child and area as is necessary .You can not trust them not to move despite their good intentions. When the needle enters the skin, it hurts and they will move. Be prepared!

VISUALIZE THE VEIN
You will develop your own technique for this, but we recommend doing most of the looking and palpation prior to applying the tourniquet. It usually causes less stress and struggle but sometimes the veins remain “hidden" until the tourniquet is applied. Look for sites where veins join together. Pediatric veins don't usually roll like those in adults tend to do, but it is still good technique to place the tourniquet fairly close to the area of cannulation.

CLEANSE THE AREA
Local protocol often dictates which cleansing agent is used. The more common ones are povidone iodine, betadine and alcohol.

PUNCTURE THE VEIN
Pierce the skin and then allow the child to settle down. Remember, this is the painful part. Now pierce the wall of the vein and look for flashback. Once flashback occurs, advance the entire catheter about 1/16th of an inch to prevent catching the plastic sheath on the wall of the vein. Now advance the entire sheath.

Remove the tourniquet, remove the metal needle portion inside the catheter (place it where no one will get stuck), insert the T -connector tubing into the hub and slowly open the IV line. If you choose to secure the needle prior to connecting the tubing, do this before you remove the metal piece. Examine the site for swelling and observe the dripping of the IV fluid.

There are several techniques for puncturing the vein, securing the needle and connecting the tubing. Select the one that you are most comfortable and successful in performing. The principles remain constant: regardless of your technique, you must:

1) Keep areas of the needle which enter the skin sterile.
2) Successfully cannulate the vein.
3) Secure the needle to prevent it being dislodged.
4) Secure the tubing. This step is vital in preventing your IV from being dislodged, especially when moving the child.

REASSESS
Infiltration is the dreaded complication of IV therapy. Look for swelling slightly above the area where the needle enters the skin. Fluid should easily drip in response to your adjustment of the tubing guide. If swelling occurs or the solution will not infuse, the catheter needs to be removed and another attempt made.

Assess often for these complications. Infiltration is painful and provides a site for possible infection.

FLUID ADMINISTRATION
After obtaining IV access, constant drip rates cannot be maintained by gravity, as in adults, and are inadequate for pediatric IV fluid replacement. Therefore, fluid is administered to a child in bolus amounts. The technique for administering a bolus to a child is demonstrated in the videotape, using equipment shown on page 39.

The amount of the bolus is determined according to the formula

20cc/kilogram over 5-20 minutes

Additional fluid boluses are repeated as indicated by the symptoms and response of the child.

To determine the kilogram weight of the child, refer back to the 1-5-10 Rule previously outlined or divide the weight in pounds by 2.2. In cases of extreme emergencies or larger children, you can divide the pound weight in half. Your medical control will help you in this determination.

INTRAOSSEOUS INFUSION
The intraosseous core of long bones provides an alternate site for the administration of fluids to children 6 years of age or less. The procedure is reserved for use when the usual areas of IV administration have not been successfully accessed and the child is in a life threatening state.

It is generally advised that two attempts at peripheral cannulation be attempted prior to choosing the intraosseous route. You may also consider this alternate site if two minutes of time have elapsed and cannulation is not successful.

Protocols for use of IO must be established by your agency medical director. On scene voice authorization must also be granted by an authorized physician or relayed from the physician via a registered nurse prior to initiating the cannulation.

A working understanding of the anatomy of bone helps guide this procedure.

The long bones of children do not completely ossify until after age six. In children older than six, the compact bone is hardened and difficult to penetrate.

The intraosseous canal is accessible by penetration of the tibia with an IO needle. You will first pierce the skin, then the periosteum or outer covering of the bone, then the ossified bone and finally enter the medullary (intraosseous) canal.

This semi-hollow area is filled with bone marrow which functions to form red blood cells. The paths by which the red blood cells move from the medullary canal into the general circulation are the same paths by which infused fluid will enter the child's circulatory system.

You may use either LR or NS fluids and all drugs of pediatric resuscitation can be administered via the intraosseous route.

The equipment, techniques of land marking and insertion are demonstrated on the videotape.

VIEW VIDEOTAPE VASCULAR ACCESS AND FLUID ADMINISTRATION -PART E

DESIRED OUTCOMES

The outcomes for this section of the program are a combination of knowledge and manipulative skills. You should practice as well as study and view the material.

After reviewing the workbook and watching the videotape, you should be able to:

1. List equipment necessary for administering vascular replacement fluid.
   _____
   _____

2. Using an IV manikin or actual child, identify/describe possible IV sites for each of the following areas: hand, arm, foot, lower leg, scalp.
   _____
   _____

3. List at least four techniques, other than a tourniquet, that are helpful in visualizing veins.
   _____
   _____
   _____
   _____

4. Using a manikin, demonstrate each of the following:
   a. Select and secure a site with a tourniquet and cleanse the area
   b. Puncture the vein, obtain flashback and advance the catheter sheath
   c. Secure the needle, attach tubing and begin fluid administration
   d. Secure the entire site and tubing

5. List two observations that indicate a non patent IV.
   a. _____
   b. _____

6. Describe the formula used to determine the amount of fluid infused per bolus.
   _____

7. Determine the quantity of fluid to be given to an average sized 6 year old in shock.
   _____

8. Describe the method of giving a fluid bolus using the 60cc syringe and stopcock.
   _____
   _____

9. Demonstrate or describe the technique/steps of starting IV fluid via the intraosseous route.

   _____
   _____
   _____

10. Describe two contraindications for using the intraosseous route.
    a. _____
    b. _____

11. Describe two complications of intraosseous cannulation.
    a. _____
    b. _____

QUIZ

The quiz questions serve as a self-evaluation. Please study the manual and review the video if you cannot easily answer the questions in this section or any of the others. You should practice the skills. Assemble the fluid and tubing; manipulate the stopcock so you are totally comfortable with the lever positions; practice vein cannulation with a manikin. Remember -you will have a very sick child if you are starting an IV -TKO's are not used with pre-hospital pediatric care!

1. Why are a volume chamber, stopcock and syringe used in the infusion of fluids for pediatric patients?
    a. To prevent excess pressure on tiny veins and infiltration
    b. To prevent air emboli
    c. To administer fluid rapidly in an accurate amount
    d. To have IV routes available if medications are required

2. Which of the following is true regarding the direction in which the handle or lever of a stopcock is pointing?
    a. The fluid will infuse in that direction
    b. The fluid will not infuse in that direction
    c. The lever should point toward the syringe at all times
    d. The fluid will infuse directly opposite the direction of the lever

3. The major complication of IV therapy is?
    a. Pain
    b. Emboli
    c. Fluid overload
    d. Infiltration

4. Which of the following is the formula which guides the volume of fluid administration?
    a. 20cc/kg
    b. 80cc/kg
    c. 2cc/kg
    d. 25cc/kg

5. Intraosseous infusion is approved for which age of children?
    a. 6-12 years
    b. Less than 3 years
    c. 12 months to 4 years
    d. 6 years and younger

6. Which of the following is a contraindication for IO cannulation?
    a. Abdominal injuries
    b. Fractures or burns to lower legs
    c. Head injury
    d. There are no contraindications if the situation is critical